Case Studies

ANATOMY & PHYSIOLOGY

Case History 14: Acid-Base Physiology

Normal Levels of Substances in the Arterial Blood:

- pH: 7.40 ± 0.05
- pCO₂ (partial pressure of carbon dioxide): 40 mm Hg
- pO₂ (partial pressure of oxygen): 90 - 100 mm Hg
- Hemoglobin - O₂ saturation: 94 - 100 %
- [HCO₃⁻]: 24 meq / liter

Vignette #1:

A 14-year-old girl with cystic fibrosis has complained of an increased cough productive of green sputum over the last week. She also complained of being increasingly short of breath, and she is noticeably wheezing on physical examination. Arterial blood was drawn and sampled, revealing the following values:

- pH: 7.30  (low)
- pCO₂: 50 mm Hg  (high)
- pO₂: 55 mm Hg  (low)
- Hemoglobin - O₂ saturation: 45 %  (low)
- [HCO₃⁻]: 24 meq / liter  (✓)

Questions:

1. What causes cystic fibrosis? Describe the pathophysiologic mechanisms of the disease.

   Enter your answer here.
   
   autosomal recessive disorder
   - excessive thick mucus in respiratory tract, pancreatich... ducts, 3 biliriany fre.

   Answer

2. How would you classify this girl's acid-base status?

   Enter your answer here.
   
   She's acidic @ 7.30

   Answer

   She's in respiratory acidosis
   (AEB: decreased arterial blood pH, elevated arterial blood pCO₂, normal arterial HCO₃⁻ concentration)
3. How does cystic fibrosis cause this acid-base imbalance?

Enter your answer here.

Always infected<br>breathing causes hyperventilation

\[ \text{PCO}_2 \text{ increases, excess CO}_2 \text{ reacts with H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{lowers pH of blood} \]

(Excess mucus causes hyperventilation)

Answer

4. How would the kidneys try to compensate for the girl's acid-base imbalance?

Enter your answer here.

Kidneys would increase rate of tubular secretion of Hydrogen ions into the renal tubules

Answer

5. This girl has also had a long history of diarrhea and poor weight gain. Explain why.

Enter your answer here.

bic of dehydration + electrolyte imbalance

She needs Real diet = protein bic excess respiration

Answer

6. List some other causes of this type of acid-base disturbance.

Enter your answer here.

Asthma, chronic bronchitis, emphysema, muscular dystrophy, Graves, Sclerosis, Choking, myopathy OD

Answer

Vignette #2:

A 76-year-old man complained to his wife of severe sub-sternal chest pains that radiated down the inside of his left arm. Shortly afterward, he collapsed on the living room floor. Paramedics arriving at his house just minutes later found him unresponsive, not breathing, and without a pulse. CPR and electroconvulsive shock were required to start his heart beating again. Upon arrival at the Emergency Room, the man started to regain consciousness, complaining of severe shortness of breath (dyspnea) and continued chest pain. On physical examination, his vital signs were as follows:

- Systemic blood pressure: 85 mm Hg / 50 mm Hg
- Heart rate: 175 beats / minute
- 120 / 80 = normal
- 60 - 100 normal
Respiratory rate 32 breaths / minute 12-18
Temperature 99.2°F 98.6

His breathing was labored, his pulses were rapid and weak everywhere, and his skin was cold and clammy. An ECG was done, revealing significant "Q" waves in most of the leads. Blood testing revealed markedly elevated creatine phosphokinase (CPK) levels of cardiac muscle origin. Arterial blood was sampled and revealed the following:

<table>
<thead>
<tr>
<th>pH</th>
<th>7.22</th>
<th>7.40 ± 0.05</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>pCO₂</td>
<td>30 mm Hg</td>
<td>410</td>
<td>Low</td>
</tr>
<tr>
<td>pO₂</td>
<td>70 mm Hg</td>
<td>90-100</td>
<td>Low</td>
</tr>
<tr>
<td>Hemoglobin - O₂ saturation</td>
<td>88 %</td>
<td>94-100</td>
<td>Low</td>
</tr>
<tr>
<td>[HCO₃⁻]</td>
<td>2 meq / liter</td>
<td>24</td>
<td>Low</td>
</tr>
</tbody>
</table>

Questions:

1. What is the diagnosis? What evidence supports your diagnosis?

   **Evidence**
   - Myocardial infarction (Heart attack)
   - Severe, radiating chest pain
   - Sudden collapse, enlarged Q waves on ECG and elevated blood-CPK levels

   **Answer**

2. How would you classify his acid-base status? What specifically caused this acid-base disturbance?

   **Answer**

3. How has his body started to compensate for this acid-base disturbance?

   **Answer**

4. What would his blood pH be if his body had not started compensating for the acid-base disturbance? Show your work.
Enter your answer here.

Normal: 7.35 and 7.45

Answer

5. List some other causes of this type of acid-base disturbance.

Enter your answer here.

DKA, Alcohol or Diabetes

Answer

Vignette #3:

An elderly gentleman is in a coma after suffering a severe stroke. He is in the intensive care unit and has been placed on a ventilator. Arterial blood gas measurements from the patient reveal the following:

- pH: 7.50
- pCO₂: 30 mm Hg
- pO₂: 100 mm Hg
- Hemoglobin - O₂ saturation: 98%
- [HCO₃⁻]: 24 meq/liter

Questions:

1. How would you classify this patient's acid-base status?

Enter your answer here.

Primary respiratory alkalosis from pH, low pCO₂, normal HCO₃ level

Answer

2. How does this patient's hyperventilation pattern raise the pH of the blood?

Enter your answer here.

Rate of CO₂ excretion from body, driving pCO₂ down, causing more free H⁺ to bind to HCO₃⁻ to form carbonic acid
3. How might the kidneys respond to this acid-base disturbance?

Enter your answer here. \( \text{text{Excrete HCO}_3^-\text{ (base) from body \rightarrow help up of pH}} \)

Answer

4. List some other causes of this type of acid-base disturbance.

Enter your answer here. \( \text{Hyperentilation by anxiety or high altitude} \)

Answer

Vignette #4:

A 28-year-old woman has been sick with the flu for the past week, vomiting several times every day. She is having a difficult time keeping solids and liquids down, and has become severely dehydrated. After fainting at work, she was taken to a walk-in clinic, where an IV was placed to help rehydrate her. Arterial blood was drawn first, revealing the following:

- pH: 7.50
- pCO2: 40 mm Hg
- pO2: 95 mm Hg
- Hemoglobin - O2 saturation: 97%
- [HCO3-]: 32 meq / liter

Questions:

1. How would you classify her acid-base disturbance?

Enter your answer here. \( \text{Metabolic Alkalosis} \)

Answer

2. Why might excessive vomiting cause her particular acid-base disturbance?

Enter your answer here. \( \text{Net loss of H}^+ \text{ ions from stomach lumen raise her pH cause metabolic alkalosis} \)
3. How would the kidneys compensate for this acid-base disturbance?

Enter your answer here. 

[Handwritten answer: hyperventilation]

Answer

4. List some other causes of this type of acid-base disturbance.

Enter your answer here.

[Handwritten answer: diuretics, aldosterone, conn's syndrome]